REMARKS

Applicants respectfully request reconsideration and allowance in view of the following remarks. After entry of this response, claims 1-8 and 19-26 will be pending in the application.

In the Office Action, the Examiner rejected claims 1-8 and claims 19-26, claims 9-18 and 27-36 having been withdrawn from consideration, with traverse, in response to the Examiner's restriction requirement. The Examiner acknowledged Applicants' election of claims 1-8 and 19-26 and made final the restriction requirement.

103(a) Rejections

In the Office Action, the Examiner rejected claims 1-8 and 19-26 under 35 U.S.C. §103(a) as allegedly being unpatentable over (1) any one of the Ladabaum et al. patents ('351, '452, '709), (2) Haller et al. ('476, '832), or (3) article Ladabaum et al. when taken in view of Horner et al. ('652) and Swierkowski ('580). Applicants respectfully traverse the rejections.

A §103(a), or obviousness, rejection is proper only when "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time of the invention was made to a person having ordinary skill in the art to which the subject matter pertains." 35 U.S.C. §103(a). The Examiner must make out a *prima facie* case for obviousness. The *in banc* Federal Circuit has held that "structural similarity between claimed and prior art subject matter, proved by combining references or otherwise, where the prior art gives reason or motivation to make the claimed compositions, creates a *prima facie* case of obviousness." *In re Dillon*, 16 U.S.P.Q. 2d 1897, 1901 (CAFC 1990). The underlying inquiries into the validity of an obvious rejection are: "(1) the scope and content of the prior art; (2) the level of ordinary skill in the prior art; (3) the differences between the claimed invention and the prior art; and (4) objective evidence of nonobviousness." *In re Dembiczak*, 175 F.3d 994, 998, (Fed. Cir. 1999). For the reasons stated below, Applicants assert that one of ordinary skill in the art would not have considered the invention obvious at the time of invention and, therefore, that Applicants' rejected claims 1-8 and 19-26 are not obvious over the prior art of record.

With hindsight, a claim of obviousness can be an easy one to make. Many inventions seem obvious with the clarity of 20-20 hindsight. However, a hindsight basis for obviousness is

inappropriate and cannot sustain a *prima facie* case of obviousness. Applicants' respectfully assert that the Examiner is judging obviousness of Applicants' invention using hindsight, and as such, should reconsider the rejections from the proper perspective of the time of Applicants' invention, without the teachings of Applicants' disclosure. With this perspective in mind and for at least the reasons set forth below, Applicants' request withdrawal of the rejections.

Independent Claims 1 and 19

In independent claims 1 and 19, Applicants claim the following:

1. An acoustic transducer comprising:

a substrate having a topside and a backside;

a microfabricated acoustic transducer formed on the topside of the substrate; and

a damping material disposed on the backside of the substrate, the damping material **suppressing substrate acoustic modes.**

19. A method for suppressing acoustic modes, the method comprising:

providing a substrate having a topside and a backside;

forming a microfabricated acoustic transducer on the topside of the substrate; and

placing a damping material on the backside of the substrate, the damping material **suppressing substrate acoustic modes.**

(emphasis added). At the time of Applicants' invention, as contrasted with the cited prior art, acoustic damping for specific substrate modes in a microfabricated ultrasonic transducer (MUT) was not contemplated because, until Applicant first observed these specific modes, it was unknown, and therefore not obvious, that they existed in MUTs and therefore required damping. Applicants' invention consists of first realizing that such specific substrate modes were problematic. Then, given the universe of potential solutions to this newly discovered problem (e.g., roughening the substrate, changing electrodes, changing support structures, etc.), Applicants' converged on the present invention (i.e., that an appropriately engineered and manufactured damping material, used on the back side of the MUT substrate, would be effective in damping the specific substrate modes). Furthermore, Applicants' have demonstrated the effectiveness their solution with experimental data.

With respect to the Ladabaum et al. patents ('351, '452, '709) and the Haller et al. patents ('476, '832), it would not have been obvious to those skilled in the art at the time of Applicants' invention that the damping of substrate acoustic modes in a MUT would be necessary. In fact, these references do not contain a single example where substrate acoustic mode ringing is evident and therefore cannot suggest or imply the prospect that such acoustic modes would be problematic. Therefore, one skilled in the art, at the time of Applicants' invention, would not have considered adding a damping material to an MUT substrate to suppress substrate acoustic modes. For at least this reason, independent claims 1 and 19 are not unpatentable as being obvious over the Ladabaum et al. patents ('351, '452, '709) and the Haller et al. patents ('476, '832).

In considering the Ladabaum et al. article in view of the Horner et al. ('652) patent and the Swierkowski ('580) patent, the difference between piezoelectric transducers and MUTs is significant. A piezoelectric transducer, being a bulk device, is known, due to volume conservation, to generate particle motion, not only at its primary radiating surface, but also at the surface opposite its primary radiating surface, and even at orthogonal surfaces. This particle motion occurs at all frequencies of operation, and has frequency dependencies upon the geometry of the piezoelectric crystal. To make high performance piezoelectric transducers, these particle motions must be damped or otherwise counteracted or controlled. There is substantial prior art, such as Horner et al. ('652), regarding damping piezoelectric transducers. However, MUT design is fundamentally different and the technology of piezoelectric transducers is not directly transferable thereto.

Microfabricated ultrasonic transducers have a thin and relatively light membrane, suspended over an evacuated cavity, that is actuated by electrostatic force. It is therefore not evident that particle motion will be created at any point other than where this membrane is vibrating. Applicants' claimed invention is the insightful result of detailed observations made after very extensive experimentation. From these observations, Applicants' determined that due to the supporting structures of the membrane and the forces transferred to the substrate electrode, certain specific acoustic modes were in fact excited in the silicon substrate. These specific acoustic modes have frequency dependencies based on the *substrate's* geometry, not the geometry of the transduction element as in piezoelectric transducers. These acoustic modes and their dependencies had not been observed prior to Applicants' very extensive experimentation,

and are not suggested or implied in the cited prior art.

Likewise, it was also not obvious at the time of Applicants' invention that the best way to suppress such previously unobserved specific acoustic modes was by applying a damping material on the back surface of the substrate. In fact, the types of backing described in Horner et al. ('652) have acoustic impedances so low that they would do nothing to kill the specific acoustic modes first observed in Applicants' MUT substrate. For example, impedances in the 2 Mrayls range, as contemplated in the prior art, are used for damping energy radiating from the piezoelectric elements in unintended directions. Damping the piezoelectric element with a much higher impedance, thereby matching that of the piezoelectric element itself (typically 10's of Mrayls), would make for a very inefficient (if not useless) transducer by reducing the energy radiating from the piezoelectric element in its intended direction.

Unique to Applicants' MUT damping approach is that only a very specific set of acoustic modes is of interest. Thus, a backing that is lossy enough, especially one matched to the acoustic impedance of the silicon substrate (i.e. ~20 Mrayls), does work to dampen the specific substrate acoustic modes without having the adverse affect of reducing the energy from the transduction element in its intended direction, as would be the case in the cited prior art.

Regarding Swierkowski ('580), this reference also relates to a piezoelectric transducer where particle motion is directed towards the channels. It could have been anticipated in Swierkowski ('580) that damping would be required in its configuration, because particle motion is occurring in all directions due to the action of the piezoelectric element (that is why absorbers 46 and 47 are taught). Furthermore, in Swierkowski ('580), the energy of the piezoelectric element is designed to go *towards the substrate*. Also, there is a relatively incompressible fluid in Swierkowski ('580) that would be expected to transmit a substantial portion of the piezoelectric element's energy to the substrate.

By contrast, in Applicants' MUT case, the transduction element's energy, except for the very specific acoustic modes transmitted through electrode and supporting structure forcing functions first observed through Applicants' experimentation, is designed to radiate from the transducer's surface in a direction away from the substrate. Also, the MUT does not have incompressible fluid. Instead the MUT has an evacuated cavity between the vibrating membrane and the substrate. One skilled in the art would not expect the mechanical motion of the

membrane to transmit its energy through the evacuated cavity towards the substrate, as would be analogous to the piezoelectric transducers of the cited prior art.

Therefore, for at least these reasons, independent claims 1 and 19 are not unpatentable as being obvious over the Ladabaum et al. article in view of the Horner et al. ('652) patent and the Swierkowski ('580) patent.

Dependent Claims 2-8 and 20-26

Claims 2-8 all ultimately depend from independent claim 1, and claims 20-26 all ultimately depend from independent claim 19. Thus, the allowability of dependent claims 2-8 and 20-26 at least follows from the allowability of independent claims 1 and 19, respectively. As such, claims 2-8 and 20-26 are allowable over the art of record.

In view of the above remarks, Applicants request the withdrawal and reconsideration of the rejections and objections. Applicants respectfully submit that the application is in a condition for allowance, and respectfully request such a Notice.

Respectfully submitted,

By [signature]
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